Lewis River Case Study Final Report

A decision-support tool for assessing watershed-scale habitat recovery strategies for ESA-listed salmonids

Appendix B: Historical Lewis River Watershed Conditions

May 2007

Historical watershed conditions

Archival information, including the Journals of Lewis and Clark (Coues 1893) and the notes and maps of the Cadastral surveys that took place from 1853-1902 (BLM 2000), provide descriptions of soils, vegetation types, tree size, and channel conditions in the Lewis River watershed from the turn of the century. In addition, historical accounts (e.g., Rice 1996, Urrutia 1998) and historical photographs provide details of pre-European settlement conditions.

European settlement over the past 160 years has transformed the vegetation, soil properties, and flow regimes in the Lewis River watershed. The riverine environments in the Pacific Northwest are geologically young and physically dynamic because of glacial and tectonic activity such as volcanoes and earthquakes. Because of this, the freshwater habitat and riparian ecosystems are intricately linked with physical processes (Collins et al. 2003). Although geology and climate are primary controls on geomorphic and hydrologic processes and gross channel morphology, vegetation and soil are intermediary controls on physical processes, such as runoff regime and sediment erosion, as well as transport and delivery to a channel.

Archaeological evidence indicates that tribes fished for salmon up to the Lewis River falls (a barrier) in the Upper Lewis River watershed. Early settlers fished the North Fork Lewis and its tributaries, upstream of Cougar, for sport and sustenance (Rice 1996). The accounts say "trout," but that was the generic name frequently used: "the river is a mountain stream, pure and clear, abounds with the finest trout and other fish." Wade (2000) provides a comprehensive and detailed review of historical and current stock status and distribution limits of each salmonid species. The life-history diversity and spatial structure of Lewis River salmonid populations have declined in response to losses in available habitat for spawning and rearing, modified habitat conditions, and numerous other extrinsic factors.

The Pleistocene continental ice sheet did not extend to the Lewis watershed, but alpine glaciers and the Missoula flood left their mark on the landscape. Volcanic activity continues to influence the landscape. Mt. St. Helens has had numerous eruptions with tephra deposits, lahars, and debris and pyroclastic flows entering the Lewis watershed (Major and Scott 1988, PacifiCorp and Cowlitz PUD 2002). Pine, Muddy, Clearwater, and Smith watersheds are those more frequently affected by volcanic activity. Research indicates that hillslope sediment production on Mt. St. Helens blast-impacted areas decreases to background levels within 5-7 years (Dinehart 1997). Although hillslope erosion decreases, floods can remobilize the massive sediment inputs that were stored in the stream. The USGS sediment data indicate that stream sediment declined during the first decade but is still high. The farthest downstream known effect of Mt. St. Helens activity is downstream of Merwin Dam, 40,000 to 50,000 years ago. Lahar runout floods also extended toward Woodland approximately 440 years ago (Major and Scott 1988). There is no evidence of the volcanic flows extending past the Pine and Muddy Creek fans since then. It is therefore unlikely that volcanic activity before the dams substantially affected chinook salmon populations.

Dominant tree species in the Lewis watershed are Douglas fir and Western hemlock. Fire disturbance is an important factor in determining where Douglas fir becomes a co-dominant in the Western hemlock zone, and this has been the case in the Lewis watershed (Agee 1993). Archival journals, maps, and photographs were used to determine vegetation types, tree size, and channel conditions before significant settlement and watershed change occurred (Coues 1893; BLM 2000; Rice 1996; Urrutia 1998). Based on this information, the Lewis watershed consisted mostly of large conifer forests (e.g., Douglas fir, cedar, Western hemlock), with fertile meadows (e.g., Speelyai and Chelatchie Prairies). Throughout the lower half of the Lewis watershed, the vegetation was described as dense stands of fir, hemlock, some cedar, alder, and maple. The undergrowth had the same tree species with sallal, vine maple, dogwood, huckleberry, devils club, rosebush, hazel, elder, barberry, thimbleberry, salmon berry, and Oregon grape. Riparian areas had fir, cedar, maple, cottonwood, alder, hemlock, gooseberry, Oregon grape, hazel, vine maple, thimbleberry, and rose bush. Marker trees ranged from small to 144 inches dbh. In later surveys from 1902 (BLM 2000), large cut trees were frequently noted, as were logged areas covered with cut dead and green timber and dense undergrowth. Oak trees were abundant near the mouth of the Lewis and along the Lower East Fork. Black cottonwood and alder were important riparian species in the lower watershed.

Cadastral surveys noted numerous accumulations of “driftwood” in the Lewis, as did steamship captains in the late 1800s. The surveyors noted that the river was clear with a brisk current and ranged from 3 to 10 feet deep (at the Willamette meridian), and that the low bottoms overflowed annually. Soils along the river were mostly sandy. At the time of the cadastral survey in the Lower East Fork (1853; BLM 2000), the channel pattern was multi-channeled (anastomosing) with connected wetland habitat and side channels (starting at approximately RM 2). This pattern was still evident in the 1938 U.S. Geologic Survey (USGS) planar survey of the East Fork (to Lucia Falls) and the North Fork. Extensive wetlands in the scour channels from the Missoula flood are evident on the maps. The surveyors noted high, sandy eroding bluffs upstream of the multi-channeled reach. These are most likely remnant slack water deposits from the Missoula flood. The survey did not extend far past Lucia Falls because of the difficult terrain. Mass wasting events occurred throughout the watershed. The surveyors noted landslides and bank slumping along the Lower East Fork. Recent landslide inventories identified areas of natural instability and ancient deep-seated landslides (PacifiCorp and Cowlitz PUD 2002, PWI 1998).

Anthropogenic Modifications

Direct Channel Modification

In the late 1800s to early 1900s, the U.S. Army Corps of Engineers removed snags and deepened the North Fork to Speelyai Creek and the Lower East Fork channels for steamships. These actions, in addition to boat wakes, created extensive bank erosion, especially in areas where forests and shrubs had been cleared to the river for farming. One person reported that 3 acres were washed away from 1890-1908 (Rice 1996). In turn, the bank erosion led the farmers to demand bank protection, which changed the channel from multi-thread to single thread with disconnected sloughs and floodplains. Gravel mining increased this effect on both branches of the river. The combination of channel and floodplain modifications has led to a loss in floodplain connectivity (Wade 2000) and a straightening of the channels (PacifiCorp and Cowlitz PUD 2002, Report WTS3). This, in turn, has produced a loss in physical floodplain processes such as flood and sediment storage.

Levees

Levees were another modification that influenced the channel pattern and floodplain connectivity. Flooding was a problem for the settlers. Cadastral surveyors in 1853 noted that the river overflowed its banks on a yearly basis in the lower watershed. Before flood control was initiated, the Lewis flooded settlements in 1867, 1894 (which lasted several weeks), 1896, and 1917, suggesting that settled areas were in the active floodplain/floodway. This led to the construction of levees. The first successful levee was built near Woodland in 1921. The construction of levees not only modified channel pattern and floodplain connectivity, it also led to increased floodplain development along the Lower Lewis River (Rice 1996). Development in the floodplain continues to pose challenges for restoring important floodplain and side channel habitat.

Riparian Management

Prior to the railroad, the river was the primary source of transportation, and so the first trees to be logged were close to the river. Along with the large trees, smaller trees were removed from the riparian forest for cordwood to supply local, Vancouver, and Portland residences, schools, churches, and businesses. The riparian vegetation, along with the uplands, was also cleared for farmland by slashing and burning (BLM 2000, Rice 1996). Much of the riparian areas in the lower watersheds were cleared, and by 1860, commercial logging was done in earnest. Douglas fir was the large tree of choice. In 1871, the first commercial logging camp and sawmill in the watershed was started, followed by more mills. As the population increased, interest in cedar for roofing materials increased, and cedar became a heavily harvested species.

Roads

Roads are chronic sources of fine sediment (Reid and Dunne 1996), especially when they are not adequately maintained (NCASI 2002). In the Upper East Fork, the mainline unpaved roads are heavily used, which displaces aggregate surface material after a few weeks of vehicular travel (PWI 1998). While the recommended cross-drain spacing is

250-500 feet depending on road slope, cross-drain spacing on mainline roads in the watershed range closer to 900 feet. Spur roads that contour the slope have few to no cross drains and are supposedly out-sloped, although road segments on a number of spurs are in-sloped with no ditch. During high-intensity storms, segments of the road network in the Upper East Fork watershed (e.g., Forest Roads 53, 42, 4220, 41, and associated spur roads) transport water in the road treads, thereby effectively extending the channel network. Any one of these factors can increase road sediment production (NACASI 2002). The North Fork watershed analysis (USFS 1996) indicates that road conditions in upper hydrologic units (HUs) are similar to those found in the East Fork.

North Fork Lewis

Current vegetation in the Upper North Fork Lewis watershed is a mix of early, mid, and late seral stage forests, various aged clear-cuts, native grasslands, shrubs, burned areas, and rock and snow in the higher elevations. Vegetation in the lower North Fork Lewis River is dominated by agricultural uses, recreational grasses (e.g., golf courses), shrubs, native grasses, and forests. The natural fire regime is not known for the North Lewis; however, volcanic eruptions caused spot fires in the 1800s. It doesn’t appear that any of these were widespread.

The construction of three large multi-purpose dams, beginning in the 1920s, was the primary change agent on the North Fork Lewis. Because the dams retain sediment and large woody debris (LWD), and alter the natural variation in peak and baseflow regime, they overshadow the influence of natural watershed processes on the freshwater habitat in the lower parts of the watershed. They are also barriers to upstream migration. The reservoirs, particularly Merwin and Swift, inundated what appears to be prime freshwater habitat, based on descriptions in the Cadastral surveys and photographs (BLM 2000), and descriptions of the area prior to the dam.

A photograph taken near Ariel before the dam shows that the channel was meandering, with a gravel-cobble substrate (Rice 1996). Before inundation, the river at Yale Reservoir had a meandering channel pattern with point bars. The floodplain was narrower than those in downstream reaches of the Lewis River (inundated by Merwin reservoir). Historical sources also indicate sloughs connected to the river where Merwin Reservoir is currently located. Throughout the river, gravel bars and islands loaded with LWD were noted, as were free and confined meanders (high bluffs).

Although the dams retain sediment, the channel below Merwin Dam does not appear to be sediment starved (PacifiCorp and Cowlitz PUD 2002, USFS 2002). Landslides may be the primary source of fine sediment to spawning gravels in the Lower North Fork. Fine sediment is delivered to the Lower North Fork through management-related mass wasting along Colvin and Johnson Creeks. Fines are approximately 92% of the total landslide sediment yield. The gravel sizes are within the range of preferred spawning sizes (PacifiCorp and Cowlitz PUD 2002, WTS3).

The channel pattern has changed from historical conditions. Sloughs and LWD accumulations are gone and the channel is straighter, possibly due to downstream gravel mining and efforts to reduce the migration of river meanders that threatened the highway in the 1940s and 1950s (PacifiCorp and Cowlitz PUD 2002). A reduction in active bars and an increase in vegetated bars and islands occurred in this reach between 1939 and 1963-1974. The area of active bars has been relatively stable since 1974.

Near Yale Reservoir, the 1892 Cadastral survey described the channel as having rich bottomlands along the North Fork Lewis River and Speelyai Creek. The uplands on a glacio-fluvial terrace above the river were covered with a heavy growth of fir, cedar, hemlock, maple, and undergrowth similar to previous descriptions of the historical conditions. The loss of riparian areas has increased potential sediment delivery to channels and decreased sediment storage due to loss of LWD recruitment.

The reach downstream of Swift Dam has responded differently to the dam than the channel downstream of Merwin Dam. Temporal channel maps indicate that the active river channel width below Swift Dam decreased following closure (PacifiCorp and Cowlitz PUD 2002). Vegetation encroaches on the former active channel. The vegetation becomes uprooted during extremely large spill events that occur every decade or so, causing channel widening. This cycle continues to be repeated. USGS gauge height data indicate that the channel aggraded after the dam was constructed, probably due to reduced discharge and velocity, which caused a decrease in sediment transport capacity. Moreover, after the dam was built the sediment yields from the watersheds feeding the bypass reach increased due to logging. Substrate is dominantly cobble and small boulder. Most of the spawning-size gravel was located downstream from Ole Creek. Under existing conditions, median summer temperatures in the Swift bypass reach are at the upper end of preferred ranges for salmonids (PacifiCorp and Cowlitz PUD 2002). Existing maximum summer temperatures exceed the optimal ranges for all salmonid species, particularly bull trout. The reach at 1 to 1.5 miles downstream of Swift Dam does not have sufficient flow to provide any spawning habitat.

East Fork Lewis

Whereas the primary disturbance factor in the North Fork Lewis has been dam construction, fire has been a critical disturbance factor in the East Fork watershed. Fire disturbance is necessary to maintain Douglas fir as a co-dominant species in the Western hemlock (*Tsuga heterophylla)* zone (Agee 1993). Where Douglas fir is co-dominant with Western hemlock, the stand-replacement fire recurrence interval is 300-500 years. However, in Douglas fir-dominated associations, the recurrence interval is only about 100-150 years. From 1902-1927, three stand-replacing fires occurred within 10-20 years of one other. Human carelessness is suspected as the cause of these fires. However, logging practices exacerbated the fire intensity by creating more fuel (USFS 1986).

In 1902, salvage logging began after the Yacolt fire and continued until 1916. Salvage logging also occurred after the other fires that took place during the early 1900s. In the case of one large fire in the 1920s, salvage logging began before the fire was controlled (USFS 1986). To remove the dead trees, additional roads and skid trails were needed. Streams were often used as skid trails (PWI 1998). In 1953, a rehabilitation plan was developed to accommodate the logging and replanting of the burned areas. The plan included 50 miles of new access roads, 200 miles of bulldozed fire trails for vehicles, 200 miles of snag-free corridors, and development of 200 water holes for pumper and tanker trucks. On Forest Service land, many non-native species (e.g., Colorado blue spruce) were planted along bulldozed hillsides.

The fires, subsequent salvage logging, and the rehabilitation plan had more impact on the watershed-level processes in the upper East Fork than any other land change. The effects on soil and runoff patterns are still evident in portions of the watershed. The effect of the rehabilitation plan in the 1950s can be observed in the landslide records and peak flows in the East Fork (PWI 1998). Landslide frequency due to management-related actions accounted for 66% of total landslide activity that occurred between 1958 and 1997 (PWI 1998). The rehabilitation plan increased the drainage density by 40% through road and skid trail construction. The magnitude of high frequency (smaller) floods increased at the Heisson gauge (USGS gauge 14222500, RM 20, 1931-1996) during periods of road extension (1950s, 1970s-80s). No similar response was observed for gauging stations in the Upper North Fork.

Large wood was removed from the stream for salvage and to provide easier passage for machinery. Also, in the 1980s, the Washington Department of Fisheries removed many remaining logjams. The Upper East Fork channel response to removal of large wood was to change from forced pool-riffle morphology to plane bed morphology and to become armored (PWI 1998, Montgomery and MacDonald 2002). Both conditions create a situation where fine sediment is not readily stored even when channel gradient would imply storage. Fines are transported downstream to the Lower East Fork where channel gradient is substantially less. Excess fines in the Lower East Fork have been noted as a problem (Wade 2000, Rawding et al. 2001). Sources of fines include fires, gravel, surface erosion, and landslides, added road density, the natural high sand banks (part of the Missoula flood deposits), and bank erosion due to riparian changes.

The Upper East Fork appears to be sediment supply-limited (PWI 1998). Gravels are particularly in shorter supply from source areas, relative to other grain-size fractions, due to the nature of hillslope deposits and recent rates of sediment production. Based on the local geology and composition of older fluvial features (e.g., mainstem terraces), it is unlikely that the East Fork system has yielded an abundance of gravels in the past.

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